UNCLASSIFIED

DEFENCE RESEARCH ESTABLISHMENT
CENTRE DE RECHERCHES POUR LA DÉFENSE
VALCARTIER, QUÉBEC

DREV - TR –2000-102

Unlimited Distribution/Distribution illimitée

CHARACTERIZATION OF AN UNEXPLODED ORDNANCE CONTAMINATED RANGE (TRACADIE RANGE) FOR POTENTIAL CONTAMINATION BY ENERGETIC MATERIALS

by

S. Thiboutot, G. Ampleman, A. Gagnon and A. Marois, DREV

November/Novembre 2000

Approved by/approuvé par

pour/for
Section Head / Chef de section

20 Nov. 2000
Date

SANS CLASSIFICATION

WARNING NOTICE

The information contained herein is proprietary to Her Majesty and is provided to the recipient on the understanding that it will be used for information and evaluation purposes only. Any commercial use, including use for manufacture, is prohibited. Release to third parties of this publication or of information contained herein is prohibited without the prior written consent of DND Canada.

© Her Majesty the Queen in Right of Canada as represented by the Minister of National Defence, 2000

REPRODUCTION QUALITY NOTICE

This document is the best quality available. The copy furnished to DRDCIM contained pages that may have the following quality problems:

: Pages smaller or Larger than normal

: Pages with background colour or light coloured printing

: Pages with small type or poor printing; and or

✓: Pages with continuous tone material or colour photographs

Due to various output media available these conditions may or may not cause poor legibility in the hardcopy output you receive.

☒ If this block is checked, the copy furnished to DRDCIM contained pages with colour printing, that when reproduced in Black and White, may change detail of the original copy.

ABSTRACT

Some operational activities of the Canadian Forces such as firing practice may cause the dispersion of energetic compounds in the environment. Energetic materials could be released immediately after the firing in the case of broken munitions or they could be released very slowly from leaching underground unexploded ordnance (UXO). Even if site characterization has been well documented over the last twenty years, only little is known about the environmental behaviour of energetic compounds in relation with unexploded ordnance. These compounds should be closely monitored due to their highly specific physical, chemical and toxicological properties and limited effort has been spent to examine this particular environmental threat. By its nature, unexploded ordnance poses a hazard to personnel and it also presents the potential of being a source for energetic materials contamination. This work was undertaken following the decision of the Department of the National Defence to close Tracadie Range as a training range. Our effort was directed towards two objectives: to ascertain that the site did not represent a threat to human health nor to the environment, and to assess the environmental impact of UXO's. This report presents the characterization of the unexploded ordnance contaminated Tracadie Range, located in Tracadie, New Brunswick. The site dynamics, the sampling strategy of soils and biomass are described along with the extraction and analytical procedures and the results are presented. The results obtained demonstrated that the presence of UXO's at the Tracadie Range does not lead to the accumulation of energetic materials in the environment.

RÉSUMÉ

Certaines activités opérationnelles des Forces canadiennes comme les exercices de tir peuvent entraîner la dispersion de composés énergétiques dans l'environnement. La libération de composés énergétiques peut être quasi immédiate lorsque la munition se casse et s'ouvre ou encore elle peut être extrêmement lente lorsqu'une munition intacte non détonnée se retrouve enterrée. Des efforts considérables ont été effectués afin de caractériser les sites potentiellement contaminés par des composés énergétiques au cours des vingt dernières années, mais on trouve très peu de documentation sur la problématique de la relation munition non détonée/contamination. La présence des composés énergétiques dans l'environnement doit être surveillée de près, car ceux-ci possèdent des propriétés particulières au point de vue physique, chimique et toxicologique. La menace directe causée par les munitions non détonnées est bien connue, mais le risque de contamination parallèle par des composés énergétiques est peu documenté. Ces travaux ont été entrepris suite à la décision du ministère de la Défense nationale de fermer le site d'entraînement de Tracadie. Nous poursuivions deux objectifs: le premier était d'assurer que le site ne présentait aucun danger ni pour la santé humaine ni pour l'environnement et le second visait à mesurer l'impact environnemental de la présence de munitions non détonées. Ce rapport présente les résultats obtenus à la suite de la caractérisation du site de Tracadie, situé au Nouveau-Brunswick. La dynamique du site, la stratégie d'échantillonnage des sols et de la biomasse, les méthodes d'extraction et d'analyse, ainsi que les résultats obtenus sont décrits. Les résultats ont démontré que la présence de munitions non détonées au site de Tracadie n'entraîne pas l'accumulation de composés énergétiques dans l'environnement.

This page is left blank

This page is left blank

TABLE OF CONTENTS

ABSTRACT/RÉSUMÉ.....i

EXECUTIVE SUMMARY.....v

NOMENCLATURE.....vii

1.0 INTRODUCTION.....1

2.0 RANGE HISTORIC/DESCRIPTION.....3

2.1 Past Military use.....3
2.2 Closing of the Range.....4
2.3 Existing Land Use.....5
2.4 Future Land Use.....6

3.0 SAMPLING STRATEGY.....7

3.1 Fate and Transport of Explosives from UXO's.....7
3.2 Geological/Hydrogeological Settings.....8
3.3 Soil Sampling.....9
3.4 Blueberry Sampling.....11
3.5 Impact of Open Detonation of UXO.....11

4.0 EXPERIMENTAL.....12

4.1 Chemicals and Equipment.....12
4.2 Sample Treatment and Laboratory Analysis.....12
4.3 Field Screening Method.....13
4.4 QA/QC.....14

5.0 RESULTS.....14

5.1 Soils.....14
5.2 Biomass.....15
5.3 Impact of Open detonation.....15

6.0 CONCLUSION AND RECOMMANDATIONS.....15

7.0 ACKNOWLEDGEMENTS.....17

8.0 REFERENCES.....18

TABLE I
FIGURES 1 to 15

This page is left blank

This page is left blank

EXECUTIVE SUMMARY

Energetic compounds are just now being recognized as environmental contaminants compared to other chemicals such as heavy metals, petroleum compounds or organic solvents. They are of concern, because of their specific chemical, physical and toxicological properties. They are also unique from the perspective that only the Department of National Defence (DND), with mining industry on a smaller extent, work with these products on a daily basis. A new international context emerged with the end of the Cold War, the closing of military bases and a growing environmental awareness. This has led Defence Research and Development Canada (CNRDC) to devote some of its resources at acquiring the necessary expertise and technologies to support the DND and the Canadian industry in finding practical, economical and effective solutions to the characterization of explosives-contaminated sites. It is one of DND's objectives to implement environmentally benign defence activities and to follow the Code for Environmental Stewardship, as presented in NDHQ Policy directive on the Canadian Forces and National Defence Policy on the Environment. This involves scrutinizing all present and past defence activities to ensure that they have no adverse impact on the surrounding environment. Some past activities have led to the dispersion of energetic materials in the environment. A potential source of leaching explosives in the environment is the presence of unexploded ordnance (UXO) on former air-to- ground or ground-to-ground firing ranges. These UXO's still contain explosive filling that may become a contamination source, should the casing allow the leaching of energetic materials in the environment. This represents a high probability scenario considering that these UXO's have been exposed to environmental stresses for often many years.

This report presents the results obtained from the characterization of the Tracadie Range located on the Acadian Peninsula. The closure of this former firing range involved returning large portion of land to the public. This range was heavily used in the Second World War timeframe and therefore it was heavily impacted with unexploded ordnance. It was imperative to clear the range from these UXO's, which is currently being done under a supervisory contract by Dillon Inc. before releasing the site to the public. It was also imperative to verify that neither the soils nor the biomass present on the range were impacted with energetic materials. This report will present the data obtained by DREV's team after a sampling campaign conducted at the Tracadie Range. The sampling was conducted using the worst case scenario pattern both for soils and biomass.

The overall work described in this report will help DND to assess the environmental impacts of former activities and will provide critical information to establish future operational requirements and procedures. Results obtained on the Tracadie Range will add critical data on the impact of the presence of unexploded ordnance on the environment. More specifically, it will allow DND to release former operational ranges to the general public with environmental stewardship.

This page is left blank

This page is left blank

NOMENCLATURE

ACN	Acetonitrile
2-ADNT	2-amino-4,6-dinitrotoluene
4-ADNT	4-amino-2,6-dinitrotoluene
2,4-DANT	2,4-diamino-6-nitrotoluene
2,6-DANT	2,6-diamino-4-nitrotoluene
CFB	Canadian Force Base
Dillon	Dillon Consulting Limited
DND	Department of National Defence
DREV	Defence Research Establishment Valcartier
EM	Energetic materials
EOD	Explosive Ordnance Disposal
HMX	Cyclo 1,3,5,7-tetramethylene-2,4,6,8 tetranitramine
HPLC	High pressure liquid chromatography
Kg	Kilogram
mg	milligram
OD	Open Detonation
Ppm	Parts per million
QA/QC	Quality Assurance/Quality Control
RDX	Cyclo-1,3,5-trimethylene-2,4,6-trinitramine
R&D	Research and Development
TNT	Trinitrotoluene
UXO	Unexploded Ordnance

1.0 INTRODUCTION

The international context with the end of the Cold War has resulted in the closing of many military bases worldwide. At the same time, a growing awareness in potential negative environmental impacts of operational military activities has led many countries to integrate Research and Development (R&D) programs related to the environmental impacts of energetic materials (EM). Over the last ten years, efforts have been dedicated internationally on the characterization of the extent of explosives contamination of a great number of ammunition plants and military depots. A large body of information exists on explosives concentrations on sites impacted by manufacturing operations (Refs. 1-4) where the contaminants most often observed are TNT (2,4,6-trinitrotoluene), RDX (1,3,5-hexahydro-1,3,5-trinitrotriazine), their manufacturing impurities and environmental transformation products (Ref. 5). In order to support the Canadian Forces in the establishment of the environmental impact of their operational activities, we published a detailed protocol for the characterization of sites contaminated by explosives. This report covers all pertinent aspects of site characterization and will serve as a reference guide in future samplings of explosives-contaminated sites (Ref. 6). EM are of concern because of their chemical, physical and toxicological properties. They are known to be both carcinogenic and mutagenic. In a general effort to assess the environmental impacts of the Canadian Forces operational activities, we have sampled many air-to-ground and ground-to-ground firing ranges. In general, low levels of multi-contamination by explosives were found, demonstrating that the detonation of ammunition is a relatively clean process, which leads to a minimal impact on the environment. However, an exception was encountered at a Canadian antitank firing range where high levels of HMX were found in the surface soils (Refs. 7-9). Similar results were obtained on a U.S. antitank firing range recently characterized (Ref. 10).

One of the highest potential sources of contamination by EM in the environment is the presence of a very large amount of Unexploded Ordnance (UXO) on most of the active and non-active firing ranges. UXO is military munitions that has been prepared for action, fired, dropped, or buried, and remains undetonated, posing a hazard to operations, personnel or material. It is estimated that millions of acres throughout the United States, including 1900 formerly used defence sites and 130 bases realignment and closure installations are impacted with UXO's (Ref. 11). UXOs are also known to be spread in huge tracks of lands in Europe. This represents an international problem, which has not been covered extensively yet. Even if site characterization has been well documented over the last twenty years, only

little is known about the environmental behaviour of energetic compounds in relation with UXO's. Limited research has been conducted in the area of fate and transport of explosive from UXO's and processes controlling their fate and transport are poorly understood. Once explosives from UXO move beyond the confines of the delivery system (mortal shell, artillery shell, rocket, etc.) the process affecting fate and transport should be similar to those associated with explosive contamination from other sources (Refs.12,13). The primary difference in fate and transport of explosives from UXO's compared to other contamination sources is the integrity of the delivery system, the transport of explosive from the ammunition and the environment (aquatic, terrestrial, wetland) in which the delivery system comes to rest.

The problematic of potential leaching of EM from UXO's was of high importance for the old Canadian Force Training Range located in Tracadie, New Brunswick. This particular range was used extensively starting in the first World War period and in the Second World War period as a firing range. This extensive training resulted in the accumulation of a very large amount of buried UXO's on the Tracadie Range. In 1995, a decision was made to return the property to the Province of New Brunswick, following the decision of closing CFB Chatham. It was then imperative to clear the range from UXO's prior the release of the land to the public. A private firm was hired (Dillon Inc.) to screen the overall range for the presence of UXO's and afterward to clear their presence by open detonation. The firm also proposed to sample soils for potential contamination by EM or their degradation products. The sampling plan proposed involved the sampling of less than 0.1 % of the range. DREV was involved as a DND consultant to review the sampling plan proposed by the industry. The proposed plan was approved but it was also decided to send a DREV's team at the Tracadie Range in order to evaluate the situation in parallel.

Moreover, a potential high threat to human health was identified at Tracadie Range related with the biomass present on the range. Blueberry picking has been conducted for years on the range, even on an industrial scale, and this activity was planned to continue after the release of the land to the province. This sensitive food source could represent a receptor of energetic materials should these compounds be present in the soils/water surrounding the plants. Phytoaccumulation of explosives in plants/roots/leaves and fruits has been documented in the past (Refs. 14-16). Many R&D efforts are now undertaken by using this capacity of plants to remove explosives from the environment and leading to phytoremediation of contaminated sites. In the case of Tracadie, it was imperative to prove that the potential of bioaccumulation of explosives by blueberry plants was not present and

that the picking of these fruits did not represent a threat to human life. Blueberry picking and analysis for their content in energetic material were then conducted in parallel with soil sampling.

This work was carried out between May 1996 and December 1997 under WU 2ng11, "Characterization of DND Sites Contaminated with Energetic Materials" and co-sponsored by a task coming from the Directorate General Environment (DGE) through the Directorate of Ammunition Program Management (DAPM).

2.0 RANGE HISTORIC/DESCRIPTION

The Tracadie Range was one of the largest Canadian Forces training range in eastern Canada with some 18 088 hectares (ha) in surface and a perimeter of 60 km. It is located approximately 8 km west of Tracadie in northeastern New Brunswick. The Tracadie Range falls within the Eastern New Brunswick Lowlands physiographic region.

2.1 Past Military Use

The range has been used for various military purposes from 1939 until the present time. Early use of the area was as an army firing range with artillery, gun and mortar ammunition being fired. This use continued through the WWII period with the last recorded artillery firing, by the 28 Field Battery RCA, occurring in 1957. However, the area is reported to have continued to be used for live firing and other army training activities up until its closure in 1994. The range was also used by the air force as an air-to-ground target area from the 1950s to 1992. During the 1995 season, field teams observed use of the range by 5 EOD Centre Gagetown to destroy UXO items recovered in northern New Brunswick. The main DND sources of information were NDHQ, Air Command, CFB Chatham and CFB Gagetown (Ref. 17). Internal files, staff reports and range records obtained from these sources provided information on the location of target areas, munitions used and, to a lesser extent, reported UXO discoveries. Additionally, base mapping that identified the location and extent of target areas, from 1919 (when the Range opened) to 1992 (the final map), was obtained from various DND sources. From these investigations it was possible to identify a wide variety of likely weapons and ammunition used at the range, as follows:

Army:
- artillery and gun - 6, 17, 18 and 25 pounder and 75 mm
- mortar - 2, 3 and 4.2 inch and 81 mm
- small arms ammunition
- ammunition types - high explosive, smoke and white phosphorous

Air force:
- practice aerial bomb - MK 106, BDU48/B, BDU33, MPBSOO3
- rockets - 2.75 inch
- bombs - MK 82 500 lb
- aircraft guns - 20 mm
- ammunition types - high explosive smoke, practice, high explosive
- incendiary and white phosphorous

Additionally, the range was used to destroy surplus and unserviceable ammunition from the former Naval Ammunition Depot Renous. Ammunition types reported to be destroyed include high explosives, white phosphorous and pyrotechnic filled munitions.

2.2 Closing of the Range

As part or the Infrastructure Reduction Program which has been prompted by the 1994 federal budget, the Department of National Defence closed the Tracadie Range. DND intends to transfer ownership of the range to the Province of New Brunswick. However, because of its history of use for artillery and air-to-ground training, the range had to be cleared of the unexploded ordnance (UXO) hazard to the degree necessary for the next proposed land use. To that end, DND initiated the survey and clearance of UXO at the Tracadie Range. The UXO survey contract was issued in April 1995 to Dillon Consulting Limited (Dillon) and its prime sub-contractor, ADI Limited (ADI). The two year contract, prepared a detailed plan and schedule for the range clearance. The approach was tied to the various land uses, to be occurring on the property after the release by DND. The Tracadie Range Survey Plan (Ref. 17) identified areas of the range expected to have high levels of UXO contamination. These were essentially target areas and surrounding lands that were identified from range records and interviews with existing and former range personnel and users. Areas expected to contain low levels, if any, of UXO contamination (identified initially by DND as Priority Release Areas) were surveyed during the 1995 field season to confirm the lack of substantial UXO contamination and to determine the extent of the requirement, if any,

for UXO clearance. The remainder of the range was surveyed during the 1996 field program to identify the presence and extent of UXO contamination and to determine the requirement for clearance. The worst UXO contaminated areas are referred as Areas 1 and 3 in this report.

2.3 Existing Land Use

Development of an effective demilitarization plan for the Tracadie Range required an understanding of present and future land uses. Complete details related with land use can be found in Ref. 17.

From 1939 to 1992, the primary use of the Tracadie Range was, of course, for the training of military personnel in the use of ordnance. Other uses were permitted in conjunction with this primary role under special arrangements and included blueberry picking, commercial forestry, woodcutting, fishing, hunting, and trapping. The range, in fact, has never been fenced and has traditionally been freely accessed by local residents as a recreational area, as well as for the aforementioned purposes. Residents acknowledge their long-term use of the range land and appear to anticipate its continued availability for community use.

2.3.1 Blueberry Cultivation and Picking

From 1951 to 1985, an area covering approximately 486 hectares and located in the northwest corner of the range was leased for blueberry cultivation. Trails in the vicinity of the former field are still discernible. Cultivation came to an end in 1985 when DND determined that it was not advisable to permit blueberry operations, largely because of the perceived risk from UXO. For these reasons and because the uncertainty of blueberry harvest timing interfered with use of the range for firing, it was recommended that the lease be not renewed. There has been no further commercial cultivation of blueberries on the range since 1985 and the former lands have been overgrown. However, blueberries grow wild in many locations on the range, including the former lease lands, and many local residents still access it for berry picking.

2.3.2 Forestry

Although much of the land on which the Tracadie Range is established had been subject to forest fires prior to its acquisition in 1939, forest cover had re-established until 1986, when forest fires in the western half of the range substantially affected the wood resources in those areas. Wood has been cut for many years. Large-scale commercial cutting was contracted for some areas, including north of Ten Mile Road and in the vicinity of the Worthington Trail. The forest fires led to favorable conditions for cultivation and wild growing of fruits.

2.3.3 Hunting, Fishing and Trapping

Hunting, fishing, and trapping are well-established public uses of the Tracadie Range and very important to local citizens. Indeed, the control provided by DND administration had until early 1996 regulated hunting, prevented poaching, and preserved water quality. The range provides large animals with a suitable habitat and is especially well suited to moose, which can be hunted during a three-day period in the fall.

2.3.4 Recreation and Tourism

The range is used extensively for recreational purposes. In addition to hunting and fishing, it is employed for walking, snowshoeing, snowmobiling and cross-country skiing. The focus of this activity is the Big Tracadie River, which offers attractive views. Community members have developed walking trails along the river. During winter, snowmobiling trails are prepared and used.

2.4 Future Land Use

An overall consensus concerning future land use can be summarized as follows:

- Reserve all lands within 1 km of either side of the Big Tracadie River for tourism and recreation-related use.

- Permit traditional activities on the balance of the lands (i.e., hunting, fishing, trapping) in conjunction with forestry and blueberry cultivation.

- Permit blueberry cultivation on the western half of the range, which was subjected to fire in 1986, particularly in the northwest area.

- Permit controlled forestry on the balance of lands consistent with a sylviculture plan providing for replanting to support sustained use.

There is very little support for residential or commercial development, except in relation to tourism and recreation on the river. It is generally conceded in this regard that municipal service networks are too far from the range boundaries and that there is abundant land in the area for these purposes in any case.

With respect to the potential contamination of soils/groundwater or biomass by energetic materials, scenarios in which the contaminants could be brought into the food chain should be carefully examined. Therefore, future activities including blueberry picking, fishing and hunting on the range represent such scenarios, should the contaminants be present in the environment. Rivers present on the Tracadie Range represent sensitive receptors toward contamination and therefore potentials for inclusion of contaminants in the human health food chain or for spreading the contamination outside of the range.

3.0 SAMPLING STRATEGY

3.1 Fate and Transport of Explosives from UXO's

The fate and transport processes that act upon UXO's depend upon the environment in which the UXO exists and the manner in which it has breached its delivery containment system. The fate and transport processes believed most applicable to explosives from UXO are shown in Fig. 1. The figure groups the fate and transport processes by the environment in which the UXO may come to rest (Ref.11). Explosives from corroded, leaking of ruptured UXO munitions in surface soils will be affected by the processes indicated in Fig. 1. The primary source of explosives is the UXO by itself, which may have been acted upon by some preliminary release mechanism. Once the UXO containment system has been breached, then dissolution of the explosive occurs. In the case of rupture of certain UXO types, the explosives may exist as free product in the soil due to spillage or may be partially contained

within the delivery system. After dissolution of the explosive has begun, fate and transport processes interact with the dissolved contaminant. The fate is a complex phenomenon, which might involve plant root uptake, which was of high concern at the Tracadie Range. As soon as the EM are free and available in the soil system, they may end up in the blueberry plants and therefore in the blueberry fruits. This was examined very carefully because the blueberry potential contamination would have represented a direct source for human intake.

3.2 Geological/Hydrogeological Settings

The geology and hydrogeology of the range was taken into account, since the fate of the explosives is directly related to these aspects as they are released from the delivery system. The Tracadie geological and hydrogeological settings are very particular. The lowlands are characterized by elevations less than 45 m and flat to gently undulating terrain, carved by watercourses. Climate is highly moderated by marine influences due to the proximity of the coast. Average annual rainfall is about 750 mm and annual snowfall about 300 cm, which is considered as high drainage. The underlying bedrock unit is primarily sandstone and conglomerate (Mississippian/Pennsylvanian Age), with potential for coal deposits in river channels or depressions. The uppermost bedrock strata of the Pennsylvanian sandstone tend to be highly fractured and permeable. Groundwater well yields of 15 liters per second are not uncommon, and yields of over 22 liters per second are known to occur in the general area. Surficial deposits are clay-loams to sandy-loams originating from sandy/clayey glacial tills mixed with thin marine sediments.

The nature of the soil is highly sandy and the underlying bedrock is 10 feet deep at the most. The site is almost at the sea level and therefore it is washed each spring when the water table is high after the snow melt. Based on these facts and on the potential slow release from discrete UXO's located randomly in a given area, we did not anticipate high concentrations of explosives. Sandy soils are known not to retain EM (Ref. 12), as opposed to high organic content soils or clay type soils.

3.3 Soil Sampling

As described in Chapter 2, the Tracadie Range is very wide and the systematic sampling of the overall range would not have been achievable. We decided to use a worst case scenario and to sample the areas in which the highest levels of EM contamination were suspected. If contamination were not found on these sites, the probability of finding accumulation on other sites would be very low. The worst case scenarios were defined by using three factors: 1- historical data on the use of the various ranges, 2- visual inspection and 3- UXO electromagnetic screening data from Dillon Inc. Firstly, the historical data pointed out in the direction of Ranges # 1 and #3 which were the two mostly heavily used ones in the past 25 years. The visual inspections of these two ranges confirmed this, with many shrapnel lying on the ground and heavily hit targets (cars or tanks) still present. Finally, Dillon confirmed that in those two areas, the electromagnetic surveys revealed the presence of the highest concentration of underground UXO's. Since field observations and electromagnetic surveys confirmed historical data, we were quite confident that the selected sites clearly represented the worst case scenario. Areas 1 and 3 were both air targets impact areas and they are identified in Tracadie records and map (Ref. 17). All the soil samples collected were composite samples collected in a wheel pattern (Fig. 2), in accordance with Ref. 6. Due to the presence of UXO's on the range, we were not allowed to collect sub-surface samples. The collected composite samples consisted of the top 10 cm of surface soil. Prior to our sampling, the range was cleared of visible UXO by performing detonation. Therefore, "underground" samples were collected by sampling freshly detonated area, in detonation holes, at various depth profiles.

The firm in charge of the UXO survey on the Tracadie range also did a soil sampling campaign parallel to the UXO survey. Soil sampling was completed concurrently with UXO survey calibration activities in 1996. Surficial soil samples (i.e., within 1 m of surface) were collected from areas considered, based on visual observations, most likely to be contaminated (i.e., in closest proximity to the exploded or unexploded ordnance). Soil samples were field screened using immunoassay type test kits for RDX and nitroaromatics. When the field screening tests indicated significant contamination, additional samples were collected for further laboratory analysis. A portion of each soil sample was analyzed for metals analysis. The results obtained by Dillon Inc. will be discussed in the conclusion of this report.

3.3.1 Area 1

Two distinct sectors were sampled in Area 1 based on the parameters highlighted in Section 3.2. The first one was around the principal target, which was located on a small mound in the center of the area (Fig. 3). A total of 18 composite samples were collected in a spiral pattern with the beginning of the spiral starting at the target. Each sample was collected at 10 m intervals in a spiral by ending up 25 m from the target. Samples 1.1 to 1.8 were located in the mound while samples 1.9 to 1.18 were located at the ground level. By using this spiral pattern, all directions were equally sampled. These samples were named 1.1 to 1.18. The results obtained are presented in Table I.

The second sector sampled in Area 1 was a rectangular field located inside a triangle formed by the access roads, northwest of the observation tower. This field was visited thoroughly by ammunition specialists for the clearance of unexploded ordnance. Many holes from the open detonation were still present on the rectangular field (Figs. 4-5). These samples were taken in a cross pattern with ten samples vertically and ten horizontally. Eighteen other samples were collected in the northwest quadrant of the rectangular field since numerous detonation holes were observed in that area. These samples were named 1.19 to 1.37 (Table I).

3.3.2 Area 3

In Area 3, three main targets were still present on the range. There were two target tanks and many cars piled up as targets. Samples were collected at 0, 1 and 2 meters of each target in all directions: north, west, east and south. This strategy was taken in a former study on other active antitank ranges and has proven to be successful (Ref. 18). Samples 3.1 to 3.4 were collected around the farthest target at the end of the range (Fig. 6) starting in the north position and going clockwise at zero meter. Samples 3.5 to 3.8 were collected at 1 meter and 3.9 to 3.12 at 2 meters. Samples 3.14 to 3.25 were collected around the other target tank, following the same pattern and Samples 3.26 to 3.37 were collected around the target cars with the same strategy. Samples 3.37 to 3.50 were collected randomly on the range in OD holes. All these samples may be found in Table I.

In Area 3, an open 500-pound bombshell was found after it had been open detonated by the EOD specialists. Burned residues were still present inside the delivery system (Fig. 7). These residues were collected and analyzed by both field and lab method to verify if the

reaction was complete and if there were still explosive traces in these residues. This particular sample was named "Res" (Table I).

3.4 Blueberry Sampling

The precise location of the collection of blueberries is not possible due to the nature of the dispersion of these samples in the environment. However, the strategy employed was again to sample the fruits that presented the highest probability of EM contamination. We sampled ten jars in Area 1 and six jars in Area 3, mainly near targets and near shrapnel (Fig. 8-12). We also sampled other blueberry growing areas, not based on the worst case scenario but based on the past and future use of the area. Firstly, six jars were collected in a region southwest of Area 3, where commercial picking of blueberries was conducted for years. Secondly, seven jars were collected in an area southest of the river that is now transferred to the Province of New Brunswick. Finally, two blueberry plants, including the roots were collected in the worst UXO/shrapnel contaminated site in Area 1. All biomass samples were frozen and brought back to DREV for analysis. Fresh blueberries were bought in the Quebec region and were used as blanks or spiked for quality control. A total of 32 biomass samples were then treated and analyzed at DREV.

3.5 Impact of Open Detonation of UXO

Before transferring the Tracadie range to the province, intensive open detonation (OD) of UXO's was conducted by Explosive Ordnance Disposal (EOD) specialists, from Dillon Inc. In order to verify the impact of this intensive OD operation, the soils were sampled before and after the open detonation of UXO's. This was perfomed twice (A and B trials). We sampled at distances of 0 , 1, 2, 3, 4, 5 and 10 m from the UXO's in all directions before and after the detonation (Figs 13,14). The 0 to 3 m samples were collected directly in the hole created by the detonation. These samples were named OD-A-0 to 10 and OD-B-0 to 10. All field analyses conducted revealed a "Low" response both for TNT and RDX, meaning that less than 0.1 ppm was detected. Samples were still brought back to the laboratory to confirm these results. All analyses confirmed the field results, showing no detection of any explosive residues.

4.0 EXPERIMENTAL

DREV's team collected samples during a five-day period in August 1996. Soils samples were analyzed on the site with an immunoassay field screening method and samples that showed positive response to the test kits were brought back at DREV for HPLC analysis. Blueberries were collected in glass jars (1l) and brought back to DREV for extraction and analysis. Soils extraction and analysis were performed following the EPA 8330 method (Ref. 19), while the extraction and analysis of blueberries was performed in accordance with Refs. 20-21.

4.1 Chemicals and Equipment

All standards for explosives analytes were obtained from Accustandard, standards for EPA 8330 method (Ref. 19). This method allows the quantitative determination of explosives and their related metabolites or impurities. The acetone used for soil extraction, homogenization of soil samples and glassware cleaning was reagent grade and was obtained from Anachemia. The methanol used in the laboratory for preparation of HPLC eluents was Sigma-Aldrich HPLC grade. Deionized water was used in the field for cleaning and for addition in acetone extracts. Laboratory grade water used for preparation of HPLC eluents was obtained from a Millipore Milli-Q Type 1 reagent grade water system. HPLC laboratory analyses performed at DREV were done with a HP Model 1090 equipped with a diode array UV detector HP Model 1100. Elution was done with 1:1 methanol-water at 1.2 ml/min and absorbance was recorded at 254 nm on a spectra-physics Model 8490 variable wavelength detector and peaks were recorded on a Hewlett-Packard 3396 digital integrator operated in the peak height mode. Field screening immunoassay test kits used for RDX and TNT were obtained from Strategic Diagnosis Inc. Lyophylization of biomass samples was performed with LABCONCO freeze dryer system Lypl-Lock 4.5.

4.2 Sample Treatment and Laboratory Analysis

For all sampling campaigns, every soil sample that led to a positive response with the test kits were kept cold (4°C) and frozen on the same day. They were kept frozen and in the dark until processed. The processing was conducted the following week at DREV. Individual

soil samples in Ziploc bags were shaken and kneaded and then emptied in aluminum pans. The soils were further homogenized by breaking up clumps with gloved hands and stirring. Further homogenization with acetone was achieved, as described in Ref. 6. Soils were extracted with acetonitrile by sonication, as described in the EPA method (Ref. 19). The extracts were treated according to Method 8330.

Blueberry samples were sampled in 1 L Masson Jars, kept cold, in the dark and frozen at the end of each sampling day. They were brought back to DREV where they were kept frozen until processed. The extraction of the blueberries was done according to Refs. 20 and 21. Samples were homogenized using a kitchen blender. Plant samples were cut in fine parts before lyophylization. The second step was to remove the aqueous content of the fruits by extensive lyophylization of the samples. Lyophylized dry fruit solids were then extracted with acetonitrile (ACN). The proportion of extracts-to-solvent was modified in order to improve the detection limits. By doing so, we were able to obtain a detection limit of 0.1 ppm in the dry fruit. A matrix spike was prepared by adding 0.1 ml of an ACN solution containing 100mg of HMX, RDX and TNT. No negative interference was caused by the fruit matrix, which would have jeopardized the quantitative evaluation of explosives concentrations in fruits. All main TNT metabolites such as 2-amino-4,6-dinitrotoluene (2-ADNT), 4-amino-2,6-dinitrotoluene, (4-ADNT), 2,4-diamino-6-nitrotoluene (2,4-DANT) and 2,6-diamino-4-nitrotoluene (2,6-DANT) were included in the HPLC standards since they would be the first ones to be suspected in a bio-transformation scenario within the biomass.

4.3 Field Screening Method

Immunoassay field screening method was selected for this sampling campaign based on the user-friendly nature of this test. The Tracadie Range was very large and no laboratory was available on site. All field tests were conducted directly in the rear cabin of the rental vehicles (Fig. 15). Both RDX and TNT test kits were performed, leading to an efficient screening for both nitramines and nitroaromatics. The results that can be obtained with this method range from Low to Hi, Low being equivalent to less than 0.1 ppm and Hi being equivalent to more than 5 ppm.

4.4 QA/QC

A program of quality assurance and quality control was conducted during the whole sampling campaign. Field blanks were collected on each site, in the surrounding area representative of the ranges sampled. All field blanks showed no contamination by energetic compounds. In general, all the analyses were performed at least in duplicates or triplicates, whenever possible. For the analytical work performed at DREV, 20% of the samples were sent to an external laboratory for confirmation. A ratio of 10% of spiked and surrogates were included in the analytical work.

5.0 RESULTS

5.1 Soils

A total of 87 composite samples were collected according to a worst case scenario pattern. From these samples, six reacted positively to the RDX test, while three reacted to the TNT test kit (Table I). All positive responses were lower than 10% on the test kit scale, except for Sample 1.15. Analysis by HPLC in triplicates of all samples that reacted positively to the field test revealed no explosive residues. The HPLC results indicated that we had nine false positive for both TNT and RDX field tests. This represents about 10 % of false positive, which is considered acceptable.

The results that we obtained are totally in agreement with recently published data on a similar site sampled in Albuquerque (Ref. 22). In the New Mexico study, explosives tests areas having the greatest potential for containing soils contaminants were identified using geophysical survey methods. From this survey, five areas were identified as heavily impacted with UXO's. A total of 310 soil samples were collected from the five respective areas. The samples were screened for many contaminants among which EM. No explosive and degradation products were detected in any of the 310 samples. Consequently, it was concluded that it is highly unlikely that significant contamination exists on that range.

In the Dillon study (Ref. 17) 48 soil samples were collected and analyzed for RDX and TNT in the field using field screening kits. Upon completion of the TNT/RDX field screening program, 10 soil samples were selected from the 48 samples, which reflected the greatest variation in field screening results (samples with TNT/RDX detected and samples

with non-detectable results). They were sent to the laboratory for confirmation of the field test kit results. Laboratory results report the presence of RDX in only one sample at a concentration of 9 mg/kg. No other explosive parameters were detected for the same sample. All other soil samples were reported as having non-detectable concentrations of explosive parameters in soil.

5.2 Biomass

Results obtained for the biomass collected proved that all samples were free of explosive residues. All analyses were conducted in triplicates and no chromatogram showed the presence of any energetic materials. Spiked samples proved that the extraction/analysis process led to quantitative evaluation of EM without any interference from the blueberry matrix.

5.3 Impact of Open Detonation

The impact of the OD activity was scrutinized extensively by sampling the largest range in Canada, located in Dundurn, where more than 95% of Canadian obsolete munition is destroyed by OD (Ref. 23). In Canadian Forces Ammunition Depot Dundurn, the soils and groundwater did not show high levels, if any, of contaminants. The Tracadie results follow the same trend. The two OD performed by the Tracadie EOD team monitored before and after OD did not show any spreading of EM in the environment. Even the ashes found in the incomplete OD of a 500-pound bomb did not show measurable traces of EM. Finally, soil samples from OD holes collected at various depths were free of explosive residues.

6.0 CONCLUSION AND RECOMMANDATIONS

In our study, none out of 87 soil samples collected showed contamination by any explosive residues. In the Dillon study, only one sample out of 48 showed the presence of RDX at a concentration of 9 mg/kg. Globally, two independent groups found that one sample collected out of 135 composite samples showed the presence of RDX. This represents a positive result for less than 1.0 % of collected samples. There are no standard threshold levels for explosive residues. However, based on our expertise, RDX found at a concentration lower than 10 mg/kg does not represent a problem or a threat.

The presence of a large quantity of UXOs on the Tracadie Range and especially in the regions where the soil sampling took place, confirmed that for that particular range, UXO's do not lead to the accumulation of explosive residues and therefore to soil contamination by explosives. The particular hydrogeologic situation with high soil drainage, the sandy nature of the soils and the dispersion pattern of UXO'S probably all contribute to this fact. Another study conducted on an old USA training range also showed the same trend (Ref. 22). It might be proven in the future that the presence of UXO does not lead to detectable traces of energetic residues in the environment. Other sampling surveys in various conditions will have to be achieved before such a general assumption could be made. Both DREV's and Dillon's sampling campaigns were based on the worst case scenario. Even if the number of samples collected on the Tracadie Range does not represent a systematic characterization of the overall range, we are highly confident that there is no risk associated with the presence of energetic residues, neither in the soil nor in the biomass.

The dispersion of UXO's over the site, combined with the way in which the explosives are released from the delivery systems can explain in large part the results obtained at Tracadie. In the scenario where explosives are released in the environment from the delivery systems, natural attenuation can take place through biotic and abiotic processes and can contribute to the degradation of explosive contaminants. Natural attenuation has already been demonstrated on a large scale and it is known that it can be observed even when high concentrations of explosives (over 100 mg/kg of TNT) are present in the soils. (Refs. 24-27). This process would likely be involved in the situation where low levels of explosives would be released in the environment trough the leakage of a UXO delivery system.

In conclusion, the results found at the Tracadie Range proved that there was no risk associated with the presence of energetic materials residues, neither in the soils nor in the biomass present on the range. This study also contributed to the overall knowledge on the environmental impact caused by UXO's on training ranges.

7.0 ACKNOWLEDGEMENTS

Range control personnel of Tracadie Range, are specially thanked for their precious help and support in all these sampling operations. More specifically, we would like to thank Capt François Leduc, formerly from DCPM, who facilitated range access. We also thank Mr. Spencer Wilson from ADS for his great assistance. This study was supported by funds from the Directorate of Environmental Protection through the Directorate of Ammunition Program Management. The project team members wish to thank them for their vision and the financial support of the program on environmental aspects of energetic materials.

8.0 REFERENCES

1. "Approaches for the Remediation of Federal Facility Sites Contaminated with Explosives or Radioactive Wastes", EPA Handbook # EPA/625/R-93/013, September 1993.

2. Cragin, J.H., Legget, D.C., Folet, B.T. and Schumacher, P.W., "TNT, RDX and HMX Explosives in Soils and Sediments, Analysis Techniques and Drying Losses", U.S.A.T.H.M.A. Report # AMX-TH-TE-FR-85038, October 1985.

3. Jenkins, T.F., Grant, C.L., Brar, G.S., Thorne, P.G., Schumeache, P.W. and Ranney, T.A., "Assessment of Sampling Error Associated with the Collection and Analysis of Soil Samples at Explosives Contaminated Sites", Field Analytical Chemistry and Technology, 1, 151-162, 1997.

4. Walsh, M.E., Jenkins, T.F. and Thorne, P.G., "Laboratory and Field Analytical Methods for Explosives Residues in Soil", Proceedings of the Symposium on Alternatives to Incineration for Disposal of Chemical Munitions and Energetic, Vol. 2, p. 17, June 1995.

5. Walsh, M.E., Jenkins, T.F., Schnitker, J.W. and Stutz, M.H., "Evaluation of SW846 Method 8330 for Characterization of Sites Contaminated with Residues of High Explosives", CRREL Special Report # 93-5, Hanover, NH, November 1993.

6. Thiboutot, S., Ampleman, G., Dubé, P., Jenkins, T.F., Walsh, M.E., Hawari, J., Spencer, B. and Paquet, L., "Protocol for the Characterization of Explosives Contaminated Sites", DREV R-9721, April 1998, UNCLASSIFIED

7. Thiboutot, S., Ampleman, G., Jenkins, T.F., Walsh, M.E., Thorne, P.G., Ranney, T.A. and Grant, G.L., "Assessment of Sampling Strategy for Explosives-Contaminated Soils", Proceedings of the 90th Annual Air and Waste Management Society Meeting, Paper # 94-WP 101.08, Toronto, June 1997.

8. Jenkins, T.F., Walsh, M.E., Thorne, P.G., Thiboutot, S, Ampleman, G., Ranney, T.A. and Grant, C.L., "Assessment of Sampling Error Associated with Collection and Analysis of Soil Samples at a Firing Range Contaminated with HMX", CRREL Special Report # 97-22, September 1997.

9. Jenkins, T.F., Thorne, P.G., Walsh, M.E., Grant, C.L., Thiboutot, S, Ampleman, G., Ranney, T.A. and Stutz, M.H., "Sampling Strategy for Site Characterization at

Explosives Contaminated Sites, "Proceedings of the second Tri-Service Environmental Technology Workshop, St-Louis, Missouri. June 1997.

10. Jenkins, T.F., Walsh, M.E., Thorne, P.G., Miyares, P.H., Ranney, T.A., Grant, C.L. and Esparza, J., "Site Characterization at the Inland Firing Range Impact Area at Ft. Ord", U.S. Army CRREL Special Report, February 998.

11. Brannon, J.M., Deliman, P., Ruiz, C., Price, C. and Quasim, M., " Conceptual Model and Process Descriptor Formulations for Fate and Transport of UXO", Army Engineer Waterways Experiment Station Vicksburg Report # WES-IRRP-99-1, February 1999.

12. Brannon, J.M., and Myers, T.E., "Review of Fate and Transport Processes of Explosives", Technical report # IRRP-97-2, US Army Engineers Waterways Experiment Station, Vicksburg, Mississippi, April 1997.

13. Townsend, D.M. and Myers, T.E., " Recent Developments in Formulating Model Descriptors for Subsurface Transformation and Sorption of TNT, RDX and HMX", Technical Report IRRP-96-1, US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, June 1996.

14. Harvey, S.D., Fellows, R.J., Cataldo, D.A., and Bean, R.M., "Fate of the Explosive Hexahydro-1,3-5-Trinitro-1,3,5-Triazine (RDX) in Soil and Bioaccumulation in Bush Bean and Hydroponic Plants", Environmental, Toxicology and Chemistry, Vol. 10, PP. 845-855, 1991.

15. Peterson, M.M., Horst, G.L., Shea, P.J. and Comfort, S.D., "Germination and Seeding Development of Switgrass and Smooth Bromegrass exposed to 2,4,6-Trinitrotoluene", Environmental pollution, Vol. 99, pp. 53-59, 1998.

16. Thomson, P.L., Ramer, L.Z. and Shnoor, L.S., "Uptake and Transformation of TNT by Hybrid Poplar Trees", Environ. Sci. Technol., Vol. 32, pp. 975-980, 1998.

17. Dillon Consulting Firm, Unexploded Ordance Survey & Clearance Plan, Tracadie Range New Brunswick, Stage I/II Report, Volume I-III, February 1997.

18. Thiboutot, S., Ampleman, G., Gagnon, A., and Marois, A., (DREV), Jenkins, T.F., Walsh, M.E., Thorne, P.G., and Ranney, T.A., (CRREL) , "Characterization of Antitank Firing Ranges at CFB Valcartier, WATC Wainwright and CFAD Dundurn", DREV R-9809, October 1998, UNCLASSIFIED

19. EPA (1994), Nitroaromatics and Nitramines by HPLC, Second Update SW 846, Method 8330, September 1994.

20. Larson, S. L., Strong, A.B. and Yost, S.L., "Analysis of Explosives in Plant Tissues: Modification to Method 8330 for Soil", US Army Engineer Waterways Experiment Station Draft Report, Vicksburg, Mississippi, May 1996.

21. Larson, S. L., Strong, A.B. and Yost, S.L., "Analsysis of Explosives in Plant Tissues: Modification to Method 8330 for Soil", Technical Report IRRP-98-5, US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, May 1998.

22. Grace, H., Johnson, J., and Middlebrooks, P., "Phase II. Environmental Baseline Survey of McCormick Ranch Kitland Air Force Base, New Mexico, Part 1-3." Report # 427248, GRAM Albuquerque, New Mexico, January 1996.

23. Ampleman, G., Thiboutot, S., Gagnon, A., Marois, A., Martel, R and Lefebvre, R., "Study of the Impacts of OB/OD Activity on Soils and Groundwater, at the Destruction Area in CFAD Dundurn", DREV R-9827, December 1998, UNCLASSIFIED.

24. Pennington, J., Miyares, P.H., Ringelberg, D.B., Zakikhani, M., Reynolds, M., Felt, D., Coffin, R., Gunnisson, D., Cifuentes, L., Fredrickson, H.L. and Jenkins, T. , "Natural Attenuation of Explosives in Soil and Water Systems at Department of Defense Sites: Final Report", US Army Corps of engineers, Wateways Experiment Station, Technical report # ACE-WES-TR-EL-9901, July 1999.

25. Pennington, J., Bowen, R., Brannon, J.M., Zakikhani, D., Gunnisson, D., Mahannah, J., Clarke, J., Jenkins, T. and Gnewuch, S., "Draft Protocol for Evaluating, Selecting, and Implementing Monitored Natural Attenuation at explosives-Contaminated Sites", US Army Corps of engineers, Wateways Experiment Station, Technical Report # ACE-WES-TR-EL-9910, September 1999.

26. Pennington, J., Gunnisson, D., Harrelson, C., Brannon, J.M., Zakikhani, D., Jenkins, T., Clack, J.U., Hayes, C.A., Meyers, T., Perkins, E., Ringelberg, D., Townsend, D., Fredrikson, H., and May, J.H., "Natural Attenuation of Explosives in Soil and Water Systems at Department of Defense Sites: Interim Report", US Army Corps of engineers, Wateways Experiment Station, Technical Report # ACE-WES-TR-EL-9908, March 1999.

27. Pennington, J., Zakikhani, D. and Harrelson, D.W., "Monitored Natural Attenuation of Explosives in Groundwater-Environmental Security Technology Certification Program Completion Report", Waterways Experiment Station, Technical Report # ACE-WES-TR-EL-9907, March 1999.

TABLE I

Field analytical method results for soils

1.1 to 1.11	Low	Low
1.12	6 %	Low
1.13	Low	Low
1.14	6 %	Low
1.15	20%	Low
1.16 to 1.37	Low	Low
Res.	5 %	7 %
3.1 to 3.10	Low	Low
3.11	1 %	3 %
3.12	5 %	9 %
3.12-3.50	Low	Low

Low: less than 0.1 ppm

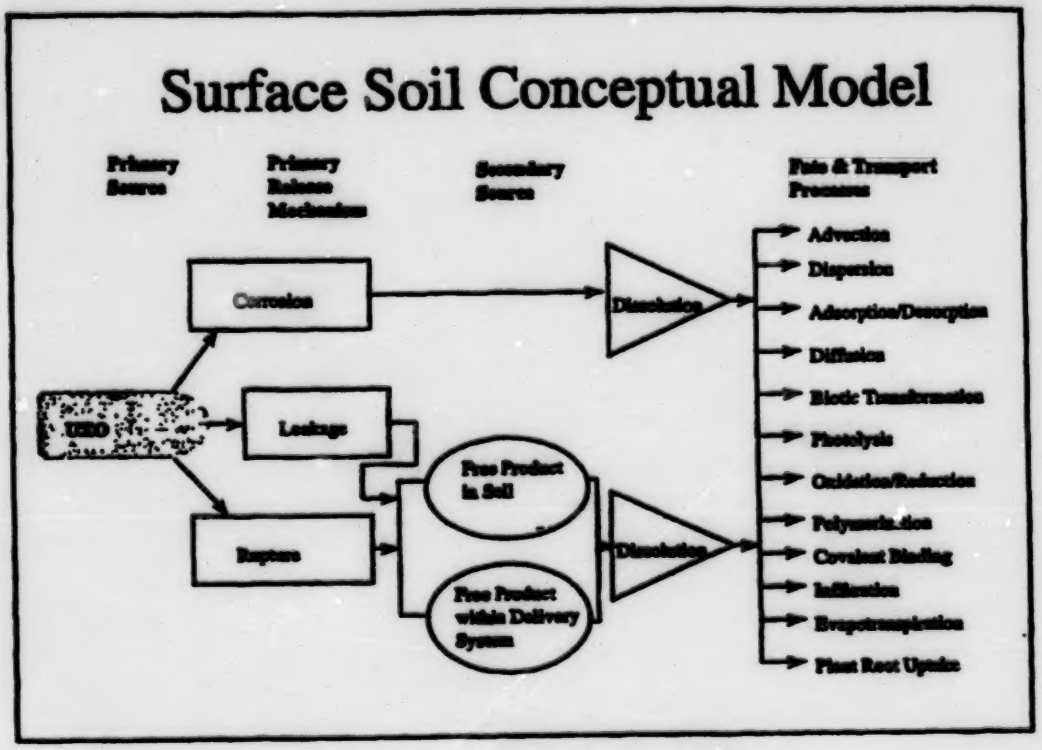

FIGURE 1 - Surface soils conceptual model

FIGURE 2 - Sampling pattern used

FIGURE 3 - Area 1 main target

FIGURE 4 - Detonation hole after clearance of UXO

FIGURE 5 - Detonation hole after clearance of UXO

FIGURE 6 - Target tank in Area 3

FIGURE 7. 500-pound bomb after open detonation

FIGURE 8 - Blueberry growing near piles of schrapnel dump

FIGURE 9 - Blueberry growing near target cars in area 3

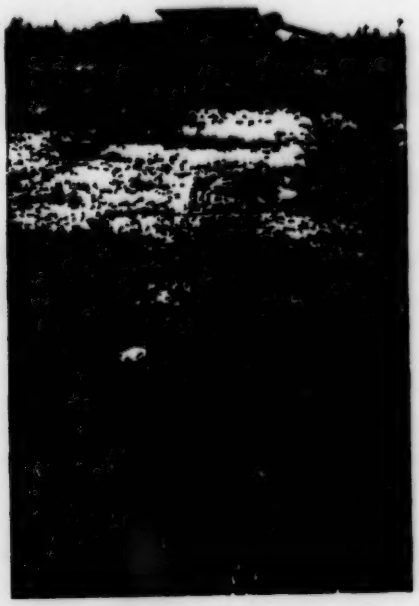

FIGURE 10- Blueberry growing near target tanks in Area 3

FIGURE 11 - Blueberry growing around an old detonation pit in Area 1

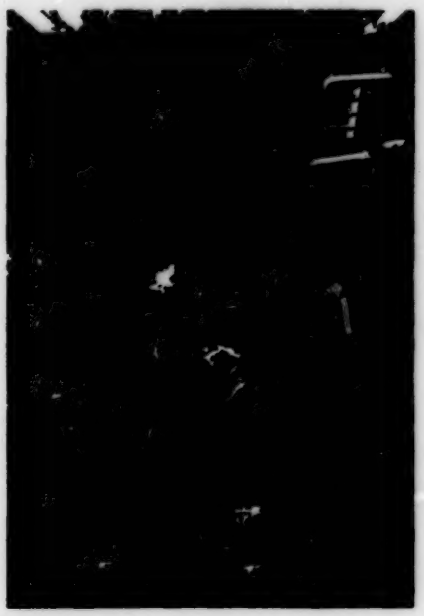

FIGURE 12 - Blueberry growing close to the target car in Area 1

FIGURE 13 - UXO before its OD by EOD team

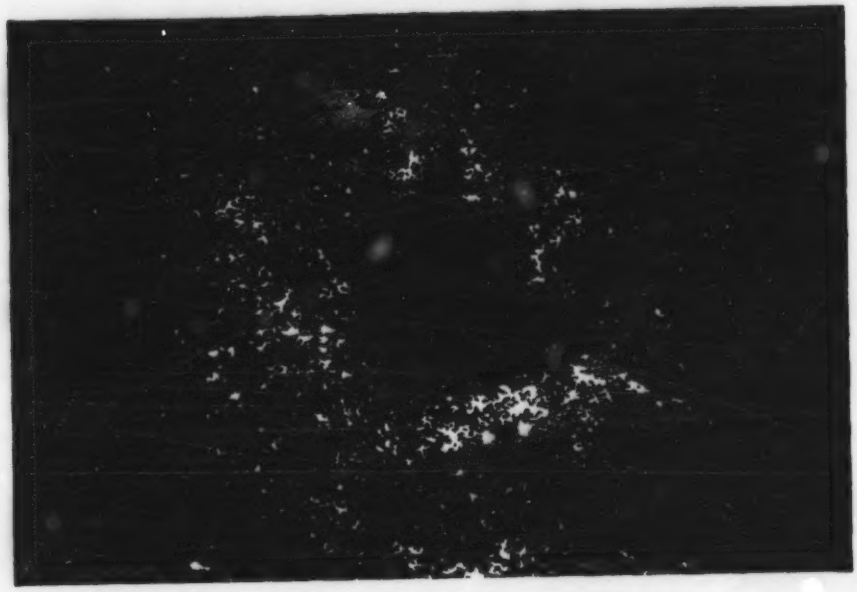

FIGURE 14 - Detonation hole after the OD of the 500-pound bomb

FIGURE 15 - Field screening tests performed directly on site

INTERNAL DISTRIBUTION

DREV-TR-2000-102

1 – Director General
1 - Deputy Director General
1 - Chief Scientist
1 - H/EM Section
6 - Document Library
1 - Dr. S. Thiboutot (author)
1 - Dr. G. Ampleman (author)
1 - Mrs. A. Gagnon (author)
1 - Mr. A. Marois (author)
1- Mrs. F. Beaupré
1- Dr. F. Wong
1 – Dr. C. Dubois
1 – Dr. L.S. Lussier
1 – Dr. S. Désilets
1 - Mr. S. Jean

UNCLASSIFIED

EXTERNAL DISTRIBUTION

DREV-TR-2000-102

1 - DRDKIM
1 - DRDKIM (unbound copy)
1 - DRDC
1 - DSTL
1 - DSTL-3
1 - DSAA
1 - DSAM
2 - DAPM-2
3 - DAPM-3
3 - DCPM
1 - DMilE
1 - DLR
1 - DMCS
1 - DARFT
3 - DGE
1 - NIMIC
NATO Headquarters
B-1110 Brussels, Belgium
1- Bibliothèque Nationale du Canada
1- ICIST
1- DTIC
2- Ms. Laurie Daneff
Crown Lands Branch
Department of Natural Resources and Energy
P.O. Box 6000
Fredericton NB
E3B 5H1
1- Ms. Anne-Marie Drake
Environment Canada
16th floor, 45 Alderney Drive
Darthmouth, Halifax
B2Y 2N6

SANS CLASSIFICATION
COTE DE SÉCURITÉ DE LA FORMULE
(plus haut niveau du titre, du résumé ou des mots-clefs)

FICHE DE CONTRÔLE DU DOCUMENT

1. PROVENANCE (le nom et l'adresse) Centre de Recherches pour la Défense, Valcartier 2459 Bouv. Pie-XI Nord Val-Bélair, Québec G3a 1X5	2. COTE DE SÉCURITÉ (y compris les notices d'avertissement, s'il y a lieu) sans classification

3 TITRE (Indiquer la cote de sécurité au moyen de l'abréviation (S, C, R ou U) mise entre parenthèses, immédiatement après le titre.)
CHARACTERIZATION OF AN UNEXPLODED ORDNANCE CONTAMINATED RANGE (TRACADIE RANGE)
FOR POTENTIAL CONTAMINATION BY ENERGETIC MATERIALS

4 AUTEURS (Nom de famille, prénom et initiales. Indiquer les grades militaires, ex.: Bleau, Maj. Louis E.)
Thiboutot, Sonia, Ampleman, Guy, Gagnon, Annie, et Marois, André

5 DATE DE PUBLICATION DU DOCUMENT (mois et année) Mai 2000	6a. NOMBRE DE PAGES 33	6b. NOMBRE DE REFERENCES 27

7. DESCRIPTION DU DOCUMENT (La catégorie du document, par exemple rapport, note technique ou mémorandum. Indiquer les dates lorsque le rapport couvre une période définie.)
Rapport du CRDV

8. PARRAIN (le nom et l'adresse)
Direction générale Environnement (DGE)

9a. NUMÉRO DU PROJET OU DE LA SUBVENTION (Spécifier si c'est un projet ou une subvention) NA	9b. NUMÉRO DE CONTRAT NA
10a. NUMÉRO DU DOCUMENT DE L'ORGANISME EXPÉDITEUR NA	10b. AUTRES NUMÉROS DU DOCUMENT N/A

11. ACCÈS AU DOCUMENT (Toutes les restrictions concernant une diffusion plus ample du document, autres que celles inhérentes à la cote de sécurité.)

- [x] Diffusion illimitée
- [ ] Diffusion limitée aux entrepreneurs des pays suivants (spécifier)
- [ ] Diffusion limitée aux entrepreneurs canadiens (avec une justification)
- [ ] Diffusion limitée aux organismes gouvernementaux (avec une justification)
- [ ] Diffusion limitée aux ministères de la Défense
- [ ] Autres

12. ANNONCE DU DOCUMENT (Toutes les restrictions à l'annonce bibliographique de ce document. Cela correspond, en principe, aux données d'accès au document (11). Lorsqu'une diffusion supplémentaire (à d'autres organismes que ceux précisés à la case 11) est possible, on pourra élargir le cercle de diffusion de l'annonce.)
Illimitée

SANS CLASSIFICATION
COTE DE LA SÉCURITÉ DE LA FORMULE
(plus haut niveau du titre, du résumé ou des mots-clefs)

SANS CLASSIFICATION

COTE DE LA SÉCURITÉ DE LA FORMULE
(plus haut niveau du titre, du résumé ou des mots-clefs)

13. SOMMAIRE (Un résumé clair et concis du document. Les renseignements peuvent aussi figurer ailleurs dans le document. Il est souhaitable que le sommaire des documents classifiés soit non classifié. Il faut inscrire au commencement de chaque paragraphe du sommaire la cote de sécurité applicable aux renseignements qui s'y trouvent, à moins que le document lui-même soit non classifié. Se servir des lettres suivantes: (S), (C), (R) ou (U). Il n'est pas nécessaire de fournir ici des sommaires dans les deux langues officielles à moins que le document soit bilingue.)

ABSTRACT

Some operational activities of the Canadian Forces such as firing practice may cause the dispersion of energetic compounds in the environment. Energetic materials could be immediately after the firing in the case of broken munitions or they could be released very slowly from leaching underground unexploded ordnance (UXO). Even if site characterization has been well documented over the last twenty years, only little is known about the environmental behaviour of energetic compounds in relation with unexploded ordnance. These compounds should be closely monitored due to their highly specific physical, chemical and toxicological properties and limited effort has been spent to examine this particular environmental threat. By its nature, unexploded ordnance poses a hazard to personnel and it also presents the potential of being a source for energetic materials contamination. This work was undertaken following the decision of the Department of the National Defense to close Tracadie Range as a training range. Our effort was directed toward two objectives: to ascertain that the site did not represent a threat to human health nor to the environment, and to assess the environmental impact of UXO's. This report presents the characterization of the unexploded ordnance contaminated Tracadie Range, located in Tracadie, New Brunswick. The site dynamics, the sampling strategy of soils and biomass are described along with extraction and analytical procedures and the results are presented. The results obtained demonstrated that the presence of UXO's at the Tracadie Range does not lead to the accumulation of energetic materials in the environment.

RÉSUMÉ

Certaines activités opérationnelles des Forces canadiennes comme les exercices de tirs peuvent entraîner la dispersion de composés énergétiques dans l'environnement. La libération de composés énergétiques peut être quasi immédiate lorsque la munition se casse et s'ouvre ou encore elle peut être extrêmement lente lorsqu'une munition intacte non-détonnée se retrouve enterrée. Des efforts considérables ont été effectués afin de caractériser les sites potentiellement contaminés par des composés énergétiques depuis les vingt dernières années mais très peu de documentation réfère à la problématique de la relation munition non détonée/contamination. La présence des composés énergétiques dans l'environnement doit être surveillée de près, car ils possèdent des propriétés particulières, du point de vue physique, chimique et toxicologique. La menace directe causée par les munitions non-détonnées est bien connue mais le risque de contamination parallèle par des composés énergétiques est peu documenté. Ces travaux ont été initiés suite à la décision du ministère de la défense nationale de fermer le site d'entraînement de Tracadie. Nous poursuivons deux objectifs: le premier était de certifier que le site ne représentait pas de danger ni pour la santé humaine ni pour l'environnement et le second visait à mesurer l'impact environnemental de la présence de munitions non-détonées. Ce rapport présente les résultats obtenus suite à la caractérisation du site de Tracadie, situé au Nouveau-Brunewok. La dynamique du site, la stratégie d'échantillonnage de sols et de biomasse, les méthodes d'extraction et d'analyse ainsi que les résultats obtenus sont décrits. Les résultats obtenus ont démontré que la présence de munitions non-détonées au site de Tracadie ne conduit pas à l'accumulation de composés énergétiques dans l'environnement.

14. MOTS-CLÉS, DESCRIPTEURS OU RENSEIGNEMENTS SPÉCIAUX (Expressions ou mots significatifs du point de vue technique, qui caractérisent un document et peuvent aider à le cataloguer. Il faut choisir des termes qui n'exigent pas de cote de sécurité. Des renseignements tels que le modèle de l'équipement, la marque de fabrique, le nom de code du projet militaire, la situation géographique, peuvent servir de mots-clés. Si possible, on doit choisir des mots-clés d'un thésaurus, par exemple le "Thesaurus of Engineering and Scientific Terms (TEST)". Nommer ce thésaurus. Si l'on ne peut pas trouver de termes non classifiés, il faut indiquer la classification de chaque terme comme on le fait avec le titre.)

Characterization
Unexploded ordnance
UXO
energetic materials
environmental impacts
contaminated ranges
firing ranges

#514919

SANS CLASSIFICATION

COTE DE SÉCURITÉ DE LA FORMULE
(plus haut niveau du titre, du résumé ou des mots-clefs)